December 2, 2002

Translation of a Patent description from German language into English

Notes:

- Additions in [square brackets] were added by the translator for clarity.
- The original text is full of long sentences with a complicated structure. This is typical for German writing, especially in technical texts where the author wants to be sure to include all important information. For clarity,the translator split these long sentences into several shorter ones without changing any of the meanings.
- If a translator wants to produce a fluent, easy to read text, a word to word translation is not always possible and the structure of whole sentences may have to change. This seems not acceptable in a patent description, where minute differences are important. I opted for a translation as accurate and close to the original as possible. I am aware of the problem, that this type of translationproduces a text which can be difficult to read and may contain grammatical errors. This approach seems the smaller of two evils.

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71) Inventor: Andreas Kwetkus, Doctor., Birmenstorf, Switzerland

56) Thefollowing patents and papers were considered before granting the new patent:
..... [see original]
[and:]
Gottschling, Rudi: "Using Hot-Gas-Filters". In: "cav Chemie" .....
Hoeflinger, Wilhelm, Hackl Albert: "Dust separation with Pre-coat-Layers on coarse metal sieves". In: "Keeping the air free of dust"....
Croom, Miles L.: "Effective selection of filter dust". In: "Chemical Engineering",

July
1993, pages 86-91
Christ A, Fietz M., Renz U.: "Basics of Hot-Gas-Filtration using ceramic filter elements. In: "VGB Power station techniques" 76, 1996, H.10, pages 838-842

The following information are based on papers and presentations submitted by the patent holder.

54) PROCESS TO CLEAN HOT EXHAUST GASES, EQUIPMENT TO APPLY THE PROCESS AND PRACTICAL APPLICATIONS OF THE PROCESS

57) This patent describes a process to clean hot exhaust gases. During an active filterphase, unfiltered, hot exhaust gases are routed through at least one high-temperature barrier filter (19, 20). Reliable operation and the avoidance of additional filtration equipment is achieved by pre-coating at least one of the ceramic high-temperature filters (19, 20) before its use. The coating material acts as a pre-filter andassists the main filter. During the active filter period, a particle-cake formson the high-temperature barrier filter (19, 20) through the assistance of the coating material. After the filtration phase, the accumulated particle-cake is removedfrom the high-temperature barrier filter (19, 20) in preparation of a new filtration cycle.

Process description

TECHNICAL AREA

The invention presented here falls into the group of exhaust-emission-treatment and covers aprocess to clean hot exhaust gases. In an active filter phase, unfiltered, hot exhaust gases are being fed through at least one ceramic high-temperature barrier filter. The patent covers also the necessary equipment to operate the process with atleast one high-temperature barrier filter. The patent covers also a practical application of the process.

PRESENTLY KNOWN PROCESSES

Several different processes to clean hot exhaust gases are presently known. Figure 1 shows a typical example of a traditional exhaust gas filtration system operating in conjunction with a gas turbine plant. An air compressor 12 coupled to a gas turbine 13 produces compressed combustion air, which is fed into a boiler 10. Boiler 10 could be aPFBC (pressurized fluid bed combustor). The exhaust gases coming from the boiler 10 are cleaned in a cyclone separator, where larger ash-particles are removed,and are then fed directly to the gas turbine 13. After the gas turbine 13, the gases are being cooled in a heat exchanger 14 and cleaned from all remaining particles in the low-temperature filter 15. In this type of low-temperature filtration, solid particles and volatile alkaline components in the exhaust gases reach the gas turbine and can generate problems.

In another known plant, the hot exhaust gases are being directly filtered. Barrier-type filters with ceramic filter elements (ceramic barrier-filters) are the most effective way to remove particles directly from the hot exhaust gases. Barrier filters or this type are for example described in the publication EP-A2-0 600 400. Figure 2 shows a typical example of such a system, in this case working together with the gasturbine already mentioned. In this application, the hot exhaust gases coming from boiler 10 are routed through a high-temperature filter 17 located before the gas turbine 13. The filter is a ceramic barrier filter. Additionally, a cyclone separator 11 may be installed before the high-temperature filter 17.

Unfortunately, large technical problems exist if the temperature of the exhaust gases to be filtered exceeds 700°C. The solid particles which should be removed from the gases are getting soft at this temperature and become "sticky". Atthese temperatures, the chemical composition of the ash particles in the exhaust gases may lead to an eutectic mixture and the risk is high, that the filter elements in the high-temperature filter 17 chemically dissolve or get plugged. It is also highly likely, that the caked-together particles can not be completely removedfrom the filter elements. For all these reasons, the dependability and reliability of conventional hot-gas filtration systems is still low. An additional problems exists with certain alkaline components in the exhaust gases. Due to their lowboiling temperature, these pollutants may pass the filter and may only condense further downstream in the process.

DESCRIPTION OF THE INVENTION

The purpose of this invention is the introduction of a process and the necessary equipmentto clean exhaust gases in such a way, that no additional filtration stages are necessary in the low-temperature region. The new process must also be highly reliable inactual operation.

The process presented above solves the problem in such away, that at least one of the ceramic high-temperature filters is being pre-coated before the start of the actual filtration phase. The coating material acts as a pre-filter and assists the main filter. During the active filter period, a particle-cake forms on the high-temperature barrier filter through the assistance of the coating material. After the filtration phase, the accumulated particle-cake is removed from the high-temperature barrier filter (19, 20) in preparation of a new filtration cycle.

The first typical characteristic of a process based on this invention is the way the pre-coating is applied. In order to pre-coat at least one of the ceramic high-temperature barrier filters, the pre-coating material is being injected upstream of this ceramic high-temperature barrier filter (a single or several filter stages might be used). In this simple way, the pre-coating material is being distributed evenly over the whole filter surface.

The second typical characteristic for a process based on this invention is the use of at least two separate ceramic high-temperature barrier filters and that at least two ofthese high temperature barrier filters are being used alternating in the exhaust gas stream. Due to the alternating operation, a continuous filtration without interruption can be achieved.

A recommended expansion of the principle of this invention is the way in which the ceramic high-temperature filters are being reconditioned. During the time when one of

two or more ceramic high-temperature barrier filters is in use, the other high-temperature barrier filter(s) are being freed from their accumulated particle-cake and arebeing re-coated with pre-coating material.
The process described in this invention covers at least one ceramic high-temperature barrier filter and is characterized by the fact, that upstream of this (or these) ceramic high-temperature barrier filter(s) a device exists to inject the pre-coating material.
A preferred arrangement of the necessary equipment based on this patent is the use of at least two ceramic high-temperature barrier filters. The ceramic high-temperature barrier filters are arranged in parallel and are interconnected via blocking devices in such a way, that one or the other of two or more ceramic high-temperature barrier filters can be switched into the exhaust gas stream. Additionally, the interconnect piping and the blocking devices are designed and built in such a way, that -asan alternative- two or more of the ceramic high-temperature barrier filters canbe switched into the exhaust gas stream in series in a tandem arrangement.
Further application arrangements can be found in the list of patent claims based on this process.

A SHORT DESCRIPTION OF THE SKETCHES

The invention is now further explained based on drawings which show examples of applications.The following applications are shown:
Figure 1shows a gas turbine plant using a low-temperature filtration system of the exhaust gases as traditionally used.
Figure 2shows a gas turbine plant using a high-temperature filtration system of the exhaust gases as traditionally used.
Figure 3is an example of a preferred application based on this invention. The drawing shows a high-temperature filtration system consisting of a pair of switchable barrier filters which may be pre-coated.

APPLICATIONS OF THE INVENTION

Figure 3shows an example of a preferred application based on this invention. The figureshows a high-temperature filtration system operating together with a gas turbine. Identical to figures 1 and 2, an air compressor 12 supplies the combustion air to the boiler 10. The air compressor 10 is installed on the same shaft as the gas turbine 13. The hot exhaust gases coming from boiler 10 pass through a filtration device and drive the gas turbine 13. Afterwards, the gases are cooled in a heat exchanger 14 and are exhausted into the atmosphere through the exhaust stack 16.
The filtration system consists of two ceramic high-temperature barrier filters 19 and 20 arranged in parallel. Exhaust gases coming from boiler 10 can be selectively routed to the entrance of either one of the two barrier filters through the use of a primary 3-way valve 21. A second and a third 3-way valve 22 and 23 are installed at the exit of the two high-temperature barrier filters 19, 20. They are plumbed in such a way, that the filtered hot exhaust gases can be routed selectively either tothe entrance of the other high-

temperature barrier filter or directly to the gas turbine13. Additional side entrances 24, 25 (indicated by arrows) are located upstream of each of the two high-temperature barrier filters 19, 20. The pre-coating material for each individual filter can be injected through these side entrances. Selectively, the two ceramic high-temperature barrier filters 19, 20 may be designed as individual filters or may be installed into one common filter housing. Before afilter 19, 20 is used and brought into contact with the exhaust gas stream, a pre-coating material is being injected into the individual filters through the dedicated side entrances 24, 25 located upstream of the filters. The purpose of the filter pre-coating is to support or enable the formation of an easily removable particle-cake on the filter surface. After a filter is pre-coated, the dust-laden exhaust gases are sent through the filter and the durst particles are filtered out on the surface of the pre-coating material layer. As more and more dust collects on the filters, the pressure drop across the filter increases. After a certain fixed time or when the pressure drop across the filter exceeds a certain critical (or pre-set) value, the active filter is removed from service and the particle-cake which has formed during active operation is removed from the filter surface.

The two filters 19, 20 are either free-standing or are separate filter units in a common filter housing. The two filters are being routed alternatively into the exhaust gas stream via the 3-way valve 21. If the high-temperature barrier filter 19 is in operation and is ducted into the exhaust gas stream, the high-temperature barrier filter20 is not used and is switched off. During this time, the particle-cake can be removed and the high-temperature barrier filter 20 can be prepared for another duty cycle by injecting fresh pre-coating material. Of course, the reverse arrangement ispossible as well. The 3-way valves 22 and 23 allow an elegant way to transfer from one filter to the other one. The valves can be used to duct the cleaned exhaust gases from the exit of the operating filter to the entrance of the idling filter. Fresh pre-coating material can now be injected into the clean gas stream and into the idling filter. Temperature losses can be minimized in this way. This operating system gives a very reliable operation, since the removal of the particle-cakefrom the filter surface is much more thorough.

The pre-coating material must be carefully selected in order to avoid eutectic mixtures. If done right, a properly selected pre-coating material can remove a large percentage of the volatile alkaline substances and also gaseous HCl and HF. No additional processes are necessary further downstream for the reduction of these components. Suitable materials for this purpose are mixtures of Alumna-Silicates with a compositiondifferent from the composition of the ash in the exhaust gases. The chemical composition of these mixtures and their ability to remove alkaline components and other components like HCl, HK is known from existing publications. Examples are:

B.Wu, K.Jaanu, F. Shadman, 3rd Int. Symposium on Gas Cleaning at high Temperatures, Karlsruhe / Germany 1996, p. 339 or

K. Jaanu,M. Orjala, 3rd Int. Symposium on Gas Cleaning at high Temperatures, Karlsruhe /Germany 1996,. p. 328.

Itis expected that the original investment costs for a system based on this patent are somewhat higher. However, these additional costs are being compensated for through a very reliable operation and the fact, that no low-temperature filter,cyclone or other equipment to remove alkaline components is required.

IDENTIFICATION LIST

10	boiler
11	cyclone
12	compressor
13	gas turbine
14	heat exchanger
15	low-temperature filter
16	exhaust duct
17	high-temperature filter
19, 20	high-temperature barrier filter
21, 22, 23	3-way valves
24, 25	injection port for pre-coat material.

PATENT CLAIMS

1. A process to clean hot exhaust gasses. During an active filter phase of this process, unfiltered, hot exhaust gases are routed through at least one ceramic high-temperature barrier filter (17, 19, 20) . **Special identification**: Before the active filter phase, at least one ceramic high-temperature barrier filter (19, 20) is being coated with a pre-coating material which acts as a pre-filter assists the main-filter.During the active filter period, a particle-cake forms on the high-temperature barrier filter (19, 20) through the assistance of the coating material. After the filtration phase, the accumulated particle-cake is removed from the high-temperature barrier filter (19, 20) in preparation of a new filtration cycle.

2. A process based on claim 1, identified by the fact that the active filter phaseis being terminated when the pressure loss across the one or several ceramic high-temperature barrier filter(s) (19, 20) exceeds a pre-assigned value.

3. A process based on claim 1, identified by the fact that the active filter phaseis being terminated after the expiration of a pre-set time.

4. A process based on claims 1 to 3, identified by the fact that the pre-coating material required to coat the ceramic high-temperature barrier filter(s) (19, 20) (one or several filters) is injected upstream of the ceramic high-temperature barrier filter(s) (19, 20) (one or several filters may be used).

5. A process based on claims 1 to 4, identified by the fact that mixtures of Aluma-Silicates are being used as pre-coating material.

6. A process based on claims 1 to 5, identified by the fact that at least two separate ceramic high-temperature barrier filters (19, 20) are used. The two or more ceramic high-temperature barrier filters (19, 20) are being brought into contact with the unfiltered, hot exhaust gases on a altenating basis.

7. A process based on claim 6, identified by the fact that during the time when one of the two or more ceramic high-temperature barrier filters (19 resp. 20) is in the active filter phase, the "other", none active ceramic high-temperature barrier filter (20 resp. 19) has its particle-cake removed and is being re-coated with pre-coating material. Either one of the two filters can be the "active" or the "none-active" filter.

8. A process based on claim 7, identified by the fact that the pre-coating of the "other", non-active ceramic high-temperature barrier filter (20 resp. 19) is done by using filtered exhaust gases from the exit of the "first", active ceramic high-temperature barrier filter (19 resp. 20). Either one of the two filters can be the "active" or the "none-active" filter.

9. A device to operate a process based on the claims 1 to 8 using at least one ceramic high-temperature barrier filter (19, 20). As a special characteristic, the process includes a device (24, 25) to inject the pre-coating material upstream of the one or several ceramic high-temperature barrier filters (19, 20).

10. A device based on claim 9, identified by the fact that at least two ceramic high-temperature barrier filters (19, 20) are installed in parallel to each other. Switching equipment exists (21, 22, 23) which selectively allows the routing of one or the other of two or more ceramic high-temperature barrier filters (19, 20) into the exhaust gas stream.

11. A device based on claim 10, identified by the fact that the switching devices (21, 22, 23) are designed and arranged in such a way, that the two or more ceramic high-temperature barrier filters (19, 20) can be selectively switched into a series arrangement and can be plumbed into the exhaust gas stream in a tandem arrangement.

12. A device based on claim 11, identified by the fact that the switching devices consist of three 3-way valves (21, 22, 23) with the following duties:

-3-way valve (21) can selectively switch the unfiltered exhaust gases to one or the other entrance of the two ceramic high-temperature barrier filters (19, 20).

-The second 3-way valve (22) can selectively switch the filtered exhaust gases coming from one of the ceramic high-temperature barrier filters (19) to the entrance of the other ceramic high-temperature barrier filter (20) or to the exit of the filtration device.

-The third 3-way valve (23) can selectively switch the filtered exhaust gases coming from the "other" ceramic high-temperature barrier filter (20)to the entrance of the first one (19) or to the exit of the filtration device.

13. A device based on claims 10 to 12, identified by the fact that both of the ceramic high-temperature barrier filters (19, 20) are designed as individual filters.

14. A device based on claims 10 to 12, identified by the fact that both of the ceramic high-temperature barrier filters (19, 20) are designed as separate filter units located in a common filter housing.

15. Application of the processes based on claims 1 to 8. The exhaust gases are being cleaned between a boiler (10) and a gas turbine (13).

Attachments:
- 2 pages of drawings

Nummer: DE 197 15 244 A1
Int. Cl.[6]: B01D 50/00
Offenlegungstag: 15. Oktober 1998

Figure 1

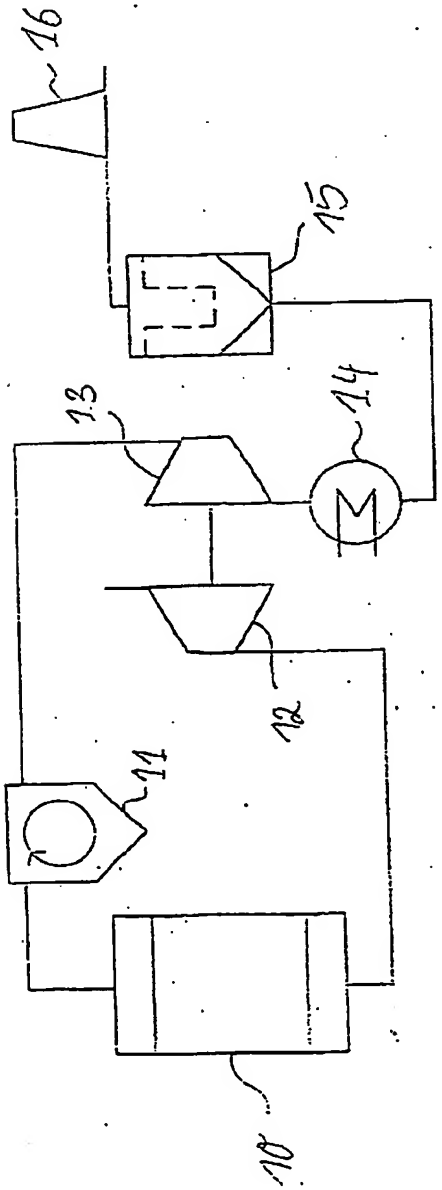

Figure 2

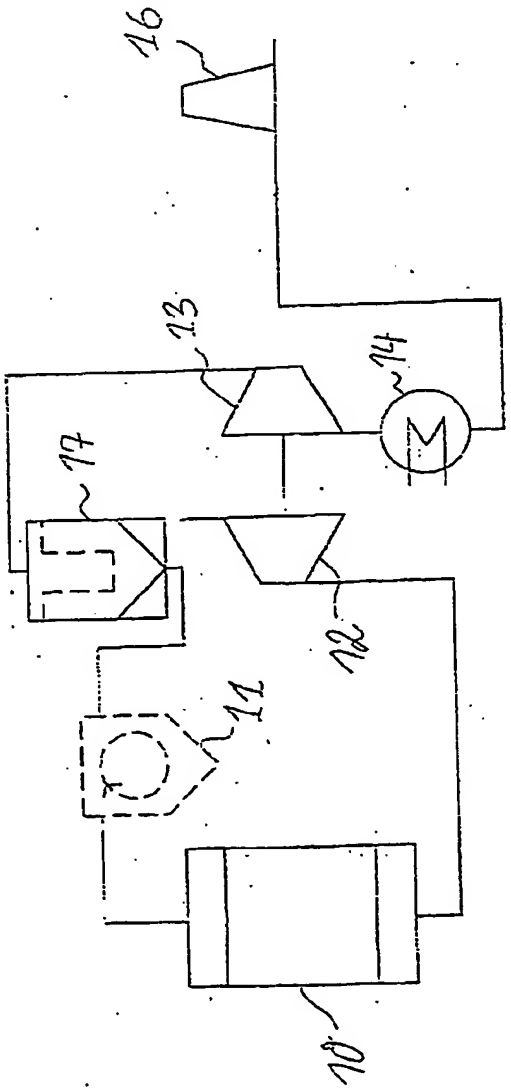

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Figure 3